The Northwestern MILLER
MILLING PRODUCTION SECTION

# How to Make Up Control Charts For Automatic Scales

By John K. Rudd
Richardson Scale Co.

Quality control charts provide a reliable tool for determining the accuracy of automatic scales. Today more and more plants are using them to keep better track of their processes.

However, before starting to make up quality control charts, there are certain things to know:

**1. What statistical quality control is.**

We can define with mathematical certainty the inherent variations in any process. We can also accurately define the precise limits of variation that can be tolerated without exceeding the specified process requirements.

When this has been done we may set down and later maintain a standard of quality for the process. We can, for instance, signal an immediate warning whenever established limits are exceeded.

How do we get this control? We start by collecting quantitative data, and then analyzing it, applying sound, proved statistical techniques. This process of collection and statistical analysis of data to regulated quality is called "statistical quality control."

Based on the laws of probability—perhaps familiar to those who have bought insurance, played poker or matched coins — statistical quality control's foundations date back many years. Only in recent years, however, has the science been developed and accepted as a reliable means of process control.

In dealing with automatic weighing, we are particularly interested in two phases of statistical quality control. The first is to find out how accurate a particular scale is. The second is to determine whether this accuracy is within the requirements of the process.

Naturally, we must know what accuracy a given scale can deliver before we can tell if the scale will meet specific requirements. This is not as simple as it sounds for the accuracy is influenced in large measure by the characteristics of the material being weighed and by the size and uniformity of the stream admitted to the weigh hopper.

**2. Fundamentals of probability.**

The laws of probability have an effect on any process or operation.

If the process or operation is not being influenced by some outside source, the effect of probability can be readily seen. For example, in tossing a coin one hundred times anyone would expect the number of heads and the number of tails to be about the same, if the coin is normal and is tossed in the same way each time.

Similarly, in one roll of one pair of dice the chances of getting a two are on in six with a normal die. If the die is loaded (an example of influence by an outside source) the law of chance, or probability, is no longer the controlling factor. These are examples that are so easily understood that we take them for granted.

Suppose we take 10 coins and toss them one at a time. We will get a certain number of heads and this number could be anything from 0 to 10. But if we repeat our tossing of the 10 coins 400 times, we begin to get a good picture of how the laws of probability affect an operation. Common sense tells us that in 400 tosses of the 10 coins we should get five heads more often than any other possible number, but it is more difficult to say exactly how many times we can expect to get, say, three heads or nine heads.

We actually tossed 10 pennies 400 times. (Fig. 1.) In the table beside the graph you will note that five heads came up 103 times. There were progressively fewer cases of four or six heads, three or seven, two or eight and one or nine heads, and there were no cases of zero or 10 heads. Plotting the frequency of occurrence against the number of heads observed gives up the graph of Fig. 1 which is very nearly symmetrical.

| No. of Heads | Freq f | Dev. From X d | $d^2$ | $f(d^2)$ |
|---|---|---|---|---|
| 0 | 0 | -5 | 25 | 0 |
| 1 | 5 | -4 | 16 | 80 |
| 2 | 14 | -3 | 9 | 126 |
| 3 | 43 | -2 | 4 | 172 |
| 4 | 82 | -1 | 1 | 82 |
| 5 | 103 | 0 | 0 | 0 |
| 6 | 89 | +1 | 1 | 89 |
| 7 | 44 | +2 | 4 | 176 |
| 8 | 15 | +3 | 9 | 135 |
| 9 | 5 | +4 | 16 | 80 |
| 10 | 0 | +5 | 25 | 0 |
| Sum | 400 | | | 940 |

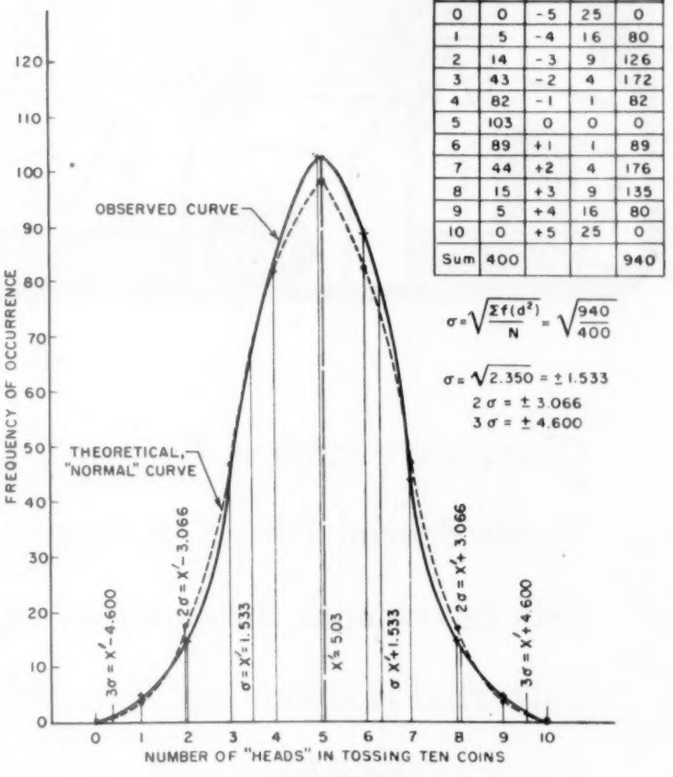
OBSERVED CURVE
THEORETICAL, "NORMAL" CURVE
FREQUENCY OF OCCURRENCE
NUMBER OF "HEADS" IN TOSSING TEN COINS
$\sigma = \sqrt{\frac{\Sigma f(d^2)}{N}} = \sqrt{\frac{940}{400}}$
$\sigma = \sqrt{2.350} = \pm 1.533$
$2\sigma = \pm 3.066$
$3\sigma = \pm 4.600$
$3\sigma = X' - 4.600$
$2\sigma = X' - 3.066$
$\sigma = X' - 1.533$
$X' = 5.03$
$\sigma X' + 1.533$
$2\sigma = X' + 3.066$
$3\sigma = X' + 4.600$

FIGURE 1

### Frequency Distribution

This curve is called a frequency distribution and is typical of the variations caused by chance alone. What does probability theory tell us? It was said that in tossing 10 coins 400 times we would expect to get five heads more often than any other number. We would also expect that the average number of heads in all 400 tosses would be five; the actual

(Continued on page 12a)

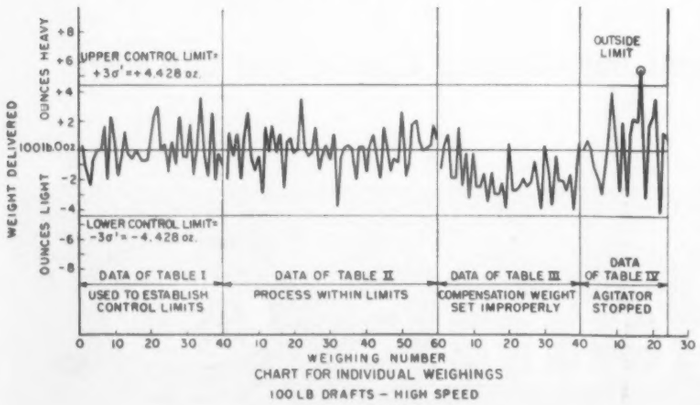


CHART FOR INDIVIDUAL WEIGHINGS
100 LB DRAFTS – HIGH SPEED
POULTRY MASH
FIGURE 2

**EDITOR'S NOTE: The author of the accompanying article, John K. Rudd, is chief research and applications engineer for the Richardson Scale Co., Clifton, N.J. Mr. Rudd received his bachelor's degree from Princeton University in 1938 and his master's degree a year later. He has been closely studying the problem of improving accuracy in high speed, automatic weighing for the past five years.**

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# Detection of Internal Infestation In Grain by Sound Amplification

Detection of hidden insect infestation in grain kernels as a means to segregate and eliminate, prior to milling, grain that is excessively contaminated by insects, is now widely practiced in flour mills in order to minimize the formation of insect fragments. Kernels which contain hidden infestation of this type and which cannot be removed by grain-cleaning operations are acknowledged to be the primary source of insect fragments in the milling process (6). A discussion of these problems and a review of means currently available to millers to achieve low-fragment counts in flour have been published (3, 7). A rigorous evaluation of several of these techniques has recently been made (12).

Tests for the detection of hidden infestation in commercial wheat which have been proposed include presumptive tests such as staining (4, 5, 8), a liquid flotation separation of insect-emerged kernels (2), isolation of insect parts for counting and identification following so-called cracking and flotation methods (6), separation by blowing kernels from which insects have emerged (9), and direct visualization of hidden infestation by radiography (10, 11).

The present report, which is one of a continuing series from this station dealing with the development of inspection techniques for internally infested grain (8, 9, 10, 11), suggests the use of electronic amplification of sounds produced by insects such as the granary weevil and rice weevil, which develop in grains internally. A preliminary report of this technique has been published (1).

The major parts of the apparatus developed for this work include an amplifier, microphone, power supply, and a soundproof box, together with auxiliary equipment for analyzing the sound patterns, such as a Tektronix oscilloscope with a Polaroid-Land attachment for recording the sound patterns produced. A description of the apparatus follows.

### Amplifier

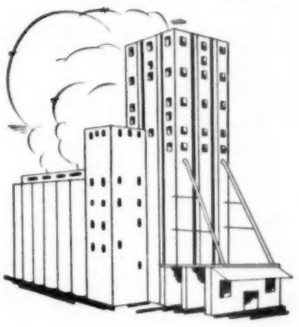
Preliminary investigations suggested that amplifiers of very high gain and low noise level would be required for these investigations, and a voltage gain of nearly 10,000,000 was projected. However, it soon became apparent that insect sounds were of sufficient magnitude that such great amplification was unnecessary. Accordingly, a circuit with less gain (about 77,000) but with very low noise-to-signal ratio was built. One tube in the circuit is a 6AC7 tiode, selected because of its low noise level. Two other tubes are type 6SJ7's which have high gain characteristics, the signal-to-noise ratio being determined by the type 6AC7. A four tube is a 6J5 used for impedance matching to the earphones. Other circuit components such as resistors and condensers are standard types with 10% tolerance of stated values. The metal amplifier box is of standard construction and afforded adequate shielding for satisfactory performance. The soundproof concrete box contained copper shielding to prevent hum pick-up from the power system.

The amplifier was constructed to use headphones but later a speaker was connected by adding an output transformer to the circuit.

The design of the soundproof box turned out to be an exacting problem since, with the amplification employed, vagrant sounds of very low intensity originating in the laboratory or the building interfered with the detection of sounds due to insects. A box constructed of several layers of fiber wallboard with air spaces between the layers proved to be inadequate. Finally a concrete box was constructed in the form of a cube with edges 2 ft. long and with walls and removable cover 2½ in. thick. Within this box was a copper container to provide electrical shielding, and within this metal container were placed two smaller boxes of fiber wallboard. The innermost boxes contained a Western Electric hearing-aid microphone attached to a small metal cup, within which the grain is placed.

### Portable Apparatus

An outgrowth of the original apparatus used for laboratory investigations described above was a compact portable device. This apparatus consisted of three components, namely an insulated box, a power supply, and an amplifier, which are plugged together with cables for use. The insulated box is a 12-in. cube made



**EDITOR'S NOTE: The authors of the accompanying article were R. E. Adams and J. E. Wolfe, electrical engineering department, and Max Milner and J. A. Shellenberger, department of flour and feed milling industries, Kansas State College. The article is adapted from a paper which appeared in Cereal Chemistry.**

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from cast ribbed aluminum plates ¾ in. in thickness for outer walls, and fluffed crepe paper insulation on the inner side walls, the bottom, and the hinged top. The innermost chamber is a 5½-in. cube containing a Western Electric microphone upon which is fastened a thin metal plate 4 in. square with turned-up edges. This permits aural examination of 50 g. of grain in a single layer. The whole assembly can be easily transported and operated in the luggage compartment of an automobile, and requires only plugging in to a standard 110-volt receptacle.

**Description of Insect Sounds**

Two distinct types of sound are associated with the larval and pupal stages, namely, a low frequency scraping noise and a high-frequency tearing or rasping sound. From repeated observations it has been deduced that the low-frequency sounds are made by the movement of larva and pupa within the kernel, and the high-frequency sounds by the chewing of the endosperm of the grain by the larva. When several infested kernels are placed on the microphone, combinations of these frequencies may appear. The frequency range of sounds due to internal insects appears to range from 200 to 8,000 cps., although the lower limit has not been accurately determined. The noise level of the amplifier system produces negligible deflection with the gain used in recording these ocillograms. The voracious eating habits of the larval stage of rice weevil (sitophilus oryza L.) has been clearly confirmed by this technique. It was also of interest to learn that, when the infested grains are disturbed in any way, the high-frequency sounds indicative of chewing usually cease and the low-frequency sounds, due to movement, continue intermittently. After a short time the high-frequency sounds reappear. An experienced observer can estimate the approximate stage of development of the insect because the sounds are slightly different in the larval and pupal stages.

This observation has suggested analysis of the recorded sound-wave patterns as a means of differentiating developmental stages as well as physiological activities. Additional studies now in progress include evaluation of the method to determine numbers of infested kernels on the basis of cumulative recording of wave peaks, analysis of differences in sound characteristics of different species which infest grain internally, relationship of frequency of feeding and movement to stage of insect development, and determination of the influence of storage temperature and humidity on the nature, frequency, and periodicity of the sound patterns produced.

One practical application of this work is a means for the rapid evaluation of the effectiveness of fumigants whereby the normal delay of several weeks required for emergence of surviving insects, now necessary to determine fumigant efficiency, can be eliminated. Another application of the principle would be a means for monitoring grain within storage bins for infestation without sampling or removing the grain from the bins, in much the same manner as permanent thermo-couple systems are now used for checking the heating of grain in storage. Work in progress suggests that selected frequency bands specific for the insect sounds can be detected, thus a means may be provided to minimize ordinary extraneous noises not caused by live infestation.

**Literature Cited**


1. Adams, R. E., Wolfe, J. E., Milner, M., and Shellenberger, J. A.—Aural detection of grain infested internally with insects; Science 118:163-164 (1953).
2. Apt, A. C.—A rapid method of examining wheat samples for infestation; Milling Production (May, 1952).
3. Farrell, E. P., and Milner, M.—Insect fragment problem in the milling industry; Kansas Agr. Expt. Sta. Circ. 291 (November, 1952).
4. Frankenfeld, J. C.—Staining methods for detecting weevil infestation in grain; U.S. Department of Agriculture, ET-No. 256 (1948).
5. Goossens, H. J.—A method for staining insect egg plugs in wheat; Cereal Chem. 26:419-420 (1949).
6. Harris, K. L., Nicholson, J. F., Randolph, Lila K., and Trawick, J. L.—An investigation of insect and rodent contamination of wheat and wheat flour; J. Assoc. Off. Agr. Chem. 35:115-158 (1952).
7. Milner, M.—Recent developments in methods of detecting internally infested wheat; Milling Production (January, 1951).
8. Milner, M., Barney, D. L., and Shel-



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lenberger, J. A.—Use of selective fluorescent stains to detect insect egg plugs on grain kernels; Science 112:791-792 (1950).
9. Milner, M., Farrell, E. P., and Katz, R.—Use of a simple blowing device to facilitate inspection of wheat for internal infestation; J. Assoc. Off. Agr. Chem. 36: 1065-1070 (1953).
10. Milner, M., Katz, R., Lee, M. R., and Pyle, W. R.—Application of the Polaroid-Land process to radiographic inspection of wheat; Cereal Chem. 30:169-170 (1953).
11. Milner, M., Lee, M. R., and Katz, R.—Application of X-ray technique to the detection of internal insect infestation of grain; J. Econ. Entomol. 43:933-935 (1950).
12. Reed, G. L., and Harris, K. L.—An evaluation of five procedures for the determination of internal insect infestation of wheat; J. Assoc. Off. Agr. Chem. 36: 138-159 (1953).

——BREAD IS THE STAFF OF LIFE——

## New Coopering Method For Box Cars Announced

MELROSE PARK, ILL. — A. J. Gerrard & Co., Melrose Park, recently announced a new method of sealing or coopering railroad freight cars for the transportation of grain or grain products.

The coopering sets utilize a new kind of Fiberglas-reinforced kraft paper, oak posts and steel strapping. In loading bix cars, the doors are first barricaded to a given height, usually 5½ ft. for grain and 8 ft.

for malt, for example. After a spout fills the car, the car's permanent doors slide shut to be sealed.

The Gerrard coopering kit consists of two sheets of paper, each large enough to barricade one door to the proper height. Vertical oak posts in the center of each doorway are connected by steel strapping through the interior width of the car. The unit is installed by nailing the edges of the paper, which are wrapped around a plywood strip, to the inside of each door, with the steel strapping between the oak posts taut across the middle of the car.

George T. Murphy, Gerrard vice president, said the coopering method brings lower costs and a reduction in claims.

The use of the oak post controls the possibility of paper bulge, the company said, and the post cuts the stress on the door posts of the car. The barricade is installed by one man. At destination, all nails can be removed by a few twists of a pinchbar.

In unloading, a hole is usually cut in the paper near the bottom of the barricade, the size of the hole determining the rate of flow. The reinforced paper will maintain a constant size hole. Another method of unloading is to cut the barricade part way down and suck out the material in the car.

The accompanying picture shows a barricade made with the Fiberglas reinforced paper and the oak center post.

## Mechanization Pays

When a fairly substantial amount of materials must be handled in any plant, it generally pays to mechanize, engineers often point out.

To show the value of mechanization, one industrial engineer cited this example: The cost of human energy is 100 to 500 times that of electricity or gasoline. If there is enough hand trucking now being done to make use of a lift truck, for example, for only an hour a day and the operator is busy the rest of the time with other duties, it pays to use a fork truck.

# The Flour Mill of the Future Is Taking Shape

As a more or less free people, we are entitled to indulge from time to time in flights of fancy, to build castles in the air, as it were, to speculate on how we would like to do things in order to bring about a change in our lives and in our businesses. It is rather different when we venture to assume the mantle of a prophet, quite oblivious of what has happened to all the prophets who have gone before.

The one redeeming feature about prophets is that their predictions are soon forgotten, and any sense of satisfaction that we have obtained at the time in proving them wrong is also soon forgotten. Never-

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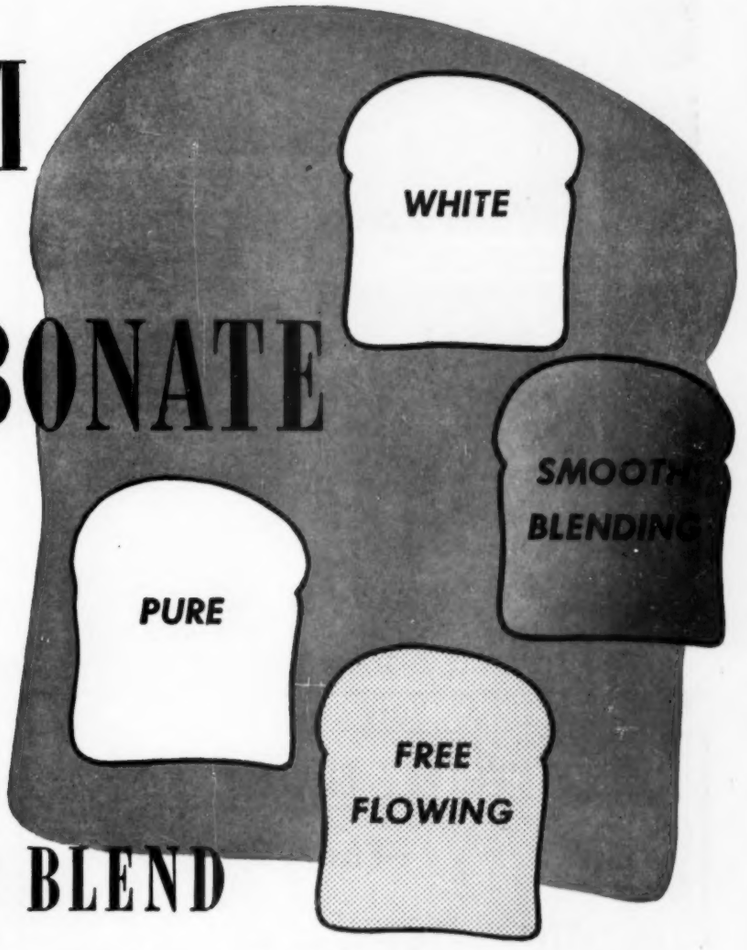


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theless a commendable feature about prophets is that they do make people think and, in so doing, draw attention to matters which might not otherwise receive consideration.

Visionaries are always appearing amongst us. Even in our own little world of flour milling, one descends from the clouds at intervals and announces that a change is imminent. To predict a change is usually a safe bet, for change there is bound to be at some time or other. As long ago as 1898, a well-known milling authority declared in a publication he issued: "In the next few years some entirely new and novel radical change in roller milling may be evolved and perfected." Fifty years have passed since that time and we are still awaiting the predicted change.

**Pneumatic Conveying**

It is also over 40 years ago that another visionary thought it was possible to convey mill stocks by air from a central point; he stated his views in public and wrote articles in support of his ideas, but he was considered a very minor prophet indeed and few listened to him. Fortunately he was wise enough to take out patent protection for his idea, a step which resulted in his name being inscribed in the Hall of Fame, so richly deserved for the benefit he has conferred on the industry. The surprising thing is that for over 40 years this wonderful idea lay almost forgotten, until one day in 1943 a fire occurred in an elevator in a tiny mill in the Swiss Alps, which destroyed the building. The owner then decided he wanted something better than elevators in his new mill, and in consequence he gave the opportunity to a milling engineer to experiment with a system of conveying mill stocks by air from a central point, the result of which was that these two men established the fact that it was possible to convey mill stocks by air and in so doing reached yet another important stage in the development of flour milling.

It is now 10 years since this form of conveying was established; yet it is only recently that the possibilities of air conveying have been fully recognized and accepted as the modern form of transport for all mill

**EDITOR'S NOTE: The accompanying article, reprinted from the British journal Milling, presents a European author's ideas on future developments in flour milling. The author is John Speight.**


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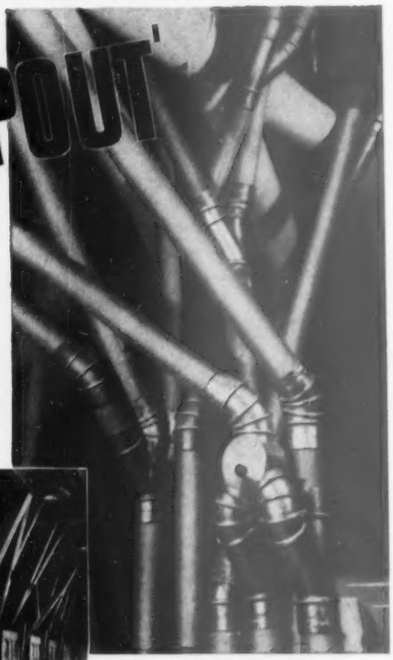

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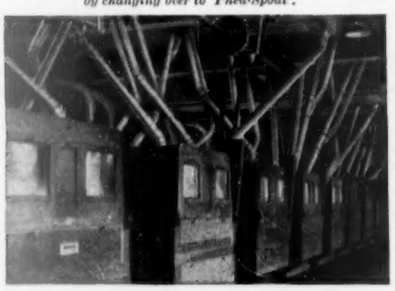

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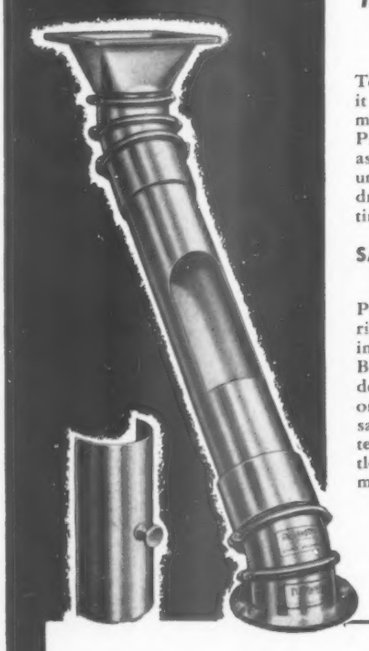

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stocks. Down through the ages there has been little change in our methods of manufacture. Machines have been considerably improved and, in consequence, are much more efficient; since 1945, however, with the coming of pneumatic conveying there has been a slow but sure change in both machines and processes of manufacture. One can understand why change must always be a slow process when one considers the enormous amount of capital invested in, say, a modern flour mill; it is sufficient to make even the boldest hestitate before committing his business to changes, the cost of which will in all probability run into astronomical figures.

The application of pneumatic conveying in the mill began a change which will undoubtedly lead to further changes, which in time will transform the manufacture of flour into a much simpler process. At this point, I almost feel that I am about to assume the mantle of a prophet, but here let me explain that this article is written in no sense of prophetic inspiration; it is a simple explanation of how developments in the milling industry are actually taking shape.

### A Tremendous Change

Pneumatic conveying in the mill has been the means of introducing a tremendous change in the future outlook of flour milling; in the opinion of many people interested in the industry, it is the greatest revolutionary change since the introduction of the roller process. One of the first apparent changes was the realization that to extract the ground product direct from the roll hopper would lead to a subsequent reduction in the height of the building necessary, with an accompanying reduction in the cost of same. The late Henry S. Crosby, one time director of General Mills, Inc. in the U.S., was firmly convinced that air power would play a greater part in the mill of the future, that it would ultimately reduce the number of machines employed, and in this way make it possible to house the whole of the machinery in a single story building.

Another phase in the development of pneumatic conveying was that the provision of a central exhaust system was unnecessary, which, of course, meant a great saving in the initial cost of equipping a mill; a further advantage was the freeing of the mill premises from pest infestation, which has resulted in a very substantial saving in time and money formerly spent in combating this trouble, to say nothing of the improvement resulting from the adoption of this hygenic form of conveying on the finished products.

Having accepted this new form of conveying in the mill, the next step was to apply it to the wheat cleaning department, where at first it proved almost unworkable, chiefly on account of the power consumption.

The prophets of woe and gloom nearly won the day; they were so busy explaining how impossible it was to convey wheat by air without a corresponding increase in power consumption that it came almost as a shock to them to learn that the question of increased power had been overcome by redesigning the principal machines in the wheat cleaning plant, where, following the precedent set in the mill itself, the central exhaust system was rendered unnecessary. The huge, clumsy machines formerly used in this department gave way to machines of more compact design; the power consumption has been reduced to a figure almost below that formerly used, and the prophets of woe have had to beat a hasty retreat. With the establishment of the pneumatic system in the wheat cleaning department, a step which has satisfied even the most "doubting Thomas" of its efficiency and one that is now accepted as the orthodox method of equipping a cleaning department, the next step was to see if it was possible to simplify the arrangement of machines or, as an alternative, to shorten the time occupied in the various processes during their passage through this department.

The most glaring instance of time lag is encountered in the conditioning process, where it can take anything from one to two hours or even longer for wheat to be treated and conditioned according to grade. For this process to be effective, and one must be careful not to say completed, the actual conditioning may take a much longer time laying in bins afterwards, etc.

### "Outer Layer Treatment"

When one considers the time and machinery employed in keeping wheat moving and undergoing treatment for all this length of time, it is only natural that suggestions should have been made that this process could with advantage be considerably improved and cheapened, but the suggestion appeared to be almost impossible of attainment until the discovery was made of a process known as the "outer layer treatment" of wheat. This was made possible by a group of German scientists, working in collaboration with a German engineering firm, who have now perfected a process for the outer layer treatment of wheat; it is, in fact, at work in continental mills, where it is proving a great success.

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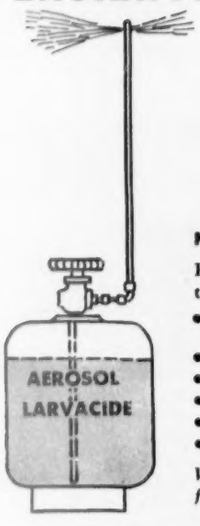


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that water penetrated into the interior of the grain in a rather slow, uneven manner. Ugrimoff, a Russian research worker at the Ecole Francaise de Meunerie in 1933, endeavored to prove how water penetrates into the interior of wheat. He found a substantial amount of water enters the endosperm from the germ end of the grain, whilst only a small quantity of water was absorbed from the beard end.

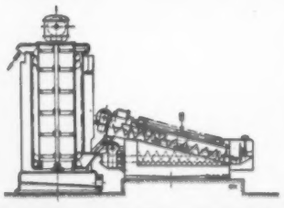
Haltmeier, a German scientist working on the same subject in 1937, proved that the hyaline layer was the main barrier to water entry into the grain, all of which goes to prove that the progress is and must be a slow process, especially if one tries to wrest secrets such as these from nature. It is now nearly 20 years since the discovery was made that the hyaline layer was a barrier to water entry into the grain, and since that time there has been a gradual realization that for water to penetrate easily into the interior of the grain, we must use the channels provided by nature for this purpose. Further research work confirmed that the hyaline layer surrounding the aleurone cells was of a water resisting character; in short, it acted more or less as a water-proof casing to portect the endosperm from the elements whilst growing.

Ugrimoff proved that water does penetrate through the hyaline layer into the endosperm, but this hyaline layer slows down the rate of penetration. It took several hours for the water to penetrate from the beard end through the hyaline layer and only half of this time for water to penetrate from the germ end. This could only lead to one conclusion, that if water could penetrate more easily from the germ end, there must be some reason for it. German scientists discovered that the reason why water entered the interior of the grain so easily from the germ end was that it must follow certain paths which traverse the skin near the germ end.

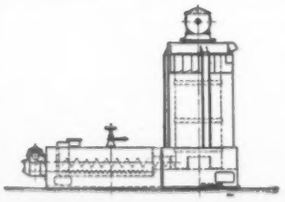
At a point where the growing grain is attached to the ear and stalk of the wheat plant, there is a group of channel-like ducts which serve to supply the growing grain with nutritive substances; as long as the growing grain is attached to the ear of plant, these nutritive substances enter the interior of the grain at this spot and these paths lead into the grain near


# BUHLER

## WASHERS & STONERS



(Type MPU Washer and Stoner with MHEa Whizzer) — Equipped with a double stoning worm and special float-off device which operates independently of water pressure, holding water consumption to a minimum. The vertical Whizzer is especially designed for extremely gentle action in the drying process.



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the aleurone layer and the scutellum.

This discovery served to show that the easiest way for water to penetrate into the interior of the grain was to use these channels provided by nature for this purpose, and this the German scientists have done by providing a process which ensures the water penetrating the interior of the grain by way of these natural channels.

Much research work has been carried out in perfecting this process, during which time it was discovered that in order to make use of these channels the grain must be in a dry state, because once it is damped the channels swell and lose some of their permeability; for this purpose, new apparatus has been designed to subject the grain to treatment in a vacuum in order to draw the air out of the channels, after which it is dropped into water or treating liquid which is readily absorbed in a very short time and enables the time of conditioning to be very substantially reduced.

The possibilities of this outer layer treatment offer great hopes for the future. Various attempts have been made in the past to add chemicals during the conditioning process, but it was found that these were more readily absorbed by the bran layers than the flour portion, which, of course, defeated the object in view. The new outer layer treatment has overcome these objections, making it possible for wheats of poor baking quality to be improved by treatment in which liquids are introduced into the outer layers of the grain.

Having now modernized and considerably shortened the time of conditioning wheat, the principal machines engaged in the wheat cleaning department, now equipped with pneumatic cleaning and conveying, has undergone a complete transformation. Gone are the clouds of dust and dirt, grime, etc., that formerly were to be found in most cleaning departments; in its place, we have an atmosphere similar to that prevailing in the mill itself, which tempts one to inquire why then the reason for a separate wheat cleaning department in an adjoining building cut off from the mill itself. The answer is that the mill of the future will be a much simpler building in which the wheat cleaning machinery will be installed alongside the actual milling plant, which could possibly be looked after and controlled by the men employed in running the mill. The conditioning plant could be housed in an adjoining building, or even in the mill basement.

**Housing**

If I were asked to design a mill where ground space was no object, following the advice of the late Henry Crosby, of General Mills, I would have no hesitation in planning all the machinery for both mill and wheat cleaning in one large single story building, with possibly a mezzanine floor to carry the auxiliary machinery.

When one comes to consider the astronomical cost of erecting a large flour mill building these days, one is almost tempted to ask if these huge and costly buildings are really necessary to house a plant of modern design for the manufacture of flour. In Europe, the tempo of production remains much the same as before the war. We employ a huge collection of slow running machines of low capacity which produces an infinitesimal amount of flour as compared with, say, the American milling plant, which in comparison produces a much greater quantity of flour that compares very favorably with flour manufactured in Europe. European methods and machines must be speeded up, and the capacities of machines increased, the overall size of machines must be reduced in order to achieve a more compact arrangement in the building.

There is no doubt that the demand for white flour is steadily declining in many countries of the world, especially in America and Europe, where large numbers of flour mills have been closed down during the past few years. It has been stated that in 1947 there were over 1,000 merchant flour mills in the U.S.; this figure has now dropped to somewhere in the region of 200. In Germany, where there are several thousand mills operating, there is a scheme afoot to close and compensate the owners of several hundred mills in an effort to put the industry on a sounder basis. Now that the milling industry in most countries has been freed from control and interfernce, the question of production cost is going to become one of paramount importance. The terrific cost of erecting huge modern buildings and the subsequent charges imposed by these costs are likely to prove a formidable barrier in any attempt to reduce production costs unless a great change takes place in our manufacturing methods.

**Tempo of Production**

I have previously suggested that machines must be reduced in size and the capacity increased in order to quicken the tempo of production;

(Continued on page 17a)

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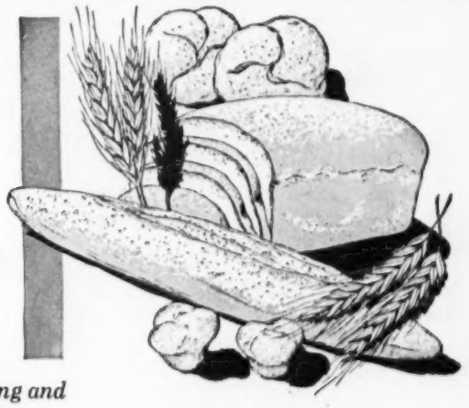

*A Brief History of Milling and Baking by* SCIENCE WRITER

## CHAPTER V. *The Evolution of Millstones*

### FROM MORTAR TO SADDLESTONE

Early man learned that grain could be ground by pounding it with a stone pestle in a mortar. From this he advanced to rubbing the grain on a saddlestone with another stone called a metate which gave better results.

### PUSH MILLS DEVELOP

Apparently from these saddlestones the push mill was developed. The surfaces of this type of mill were grooved and it was found that the shearing action was helped if the grooves were not parallel but crossed each other at acute angles. This discovery has been carried over to our day; the rollers of modern mills are so arranged for efficiency.

With better implements grinding speed increased. Then it was found that a steady supply of grain fed to the mill resulted in greater production. So the upper stone was hollowed and slotted to allow continuous feed.

### LEVER MILLS ENTER

A logical development of the push mill was the lever mill which allowed its operator to exert the force of his entire body. It increased yields so greatly that it replaced saddlestones and push mills. In fact, the level mill was an industrial machine and caused far-reaching changes to occur in the milling of grains.

### HOURGLASS MILLS & QUERNS

Next came Delian and hourglass mills. Probably these developed because the action of the lever mill in an arc suggested the greater efficiency of using a circular motion. The hourglass mill was more productive because the upper stone was suspended over the lower with both grinding surfaces running parallel.

Another development which used rotary motion was the quern which probably was developed for home grinding. In this device, too, the upper stone was suspended over the lower. As its design was refined, it gained an adjustment which allowed the grind to be changed.

### FROM QUERN TO MILLSTONE

The step from quern to millstones as we know them followed logically because it was discovered that the freely-turning upper stone could be greatly increased in size and rotated on its axle by sources of much more power than could be exerted by men or animals.

### MILLING AND NUTRITION IMPROVE STEADILY

Just as more efficient milling practices have developed over the years, so has our knowledge of good nutrition. Today millers and bakers restore to white bread and flour important values which are lost unavoidably during milling. They do this by the simple process of enriching their good foods with vitamins $B_1$, $B_2$, niacin, iron and, in some cases, calcium for better nutrition.

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*The next chapter* titled: "Waterwheels and Millstones" will be published soon.

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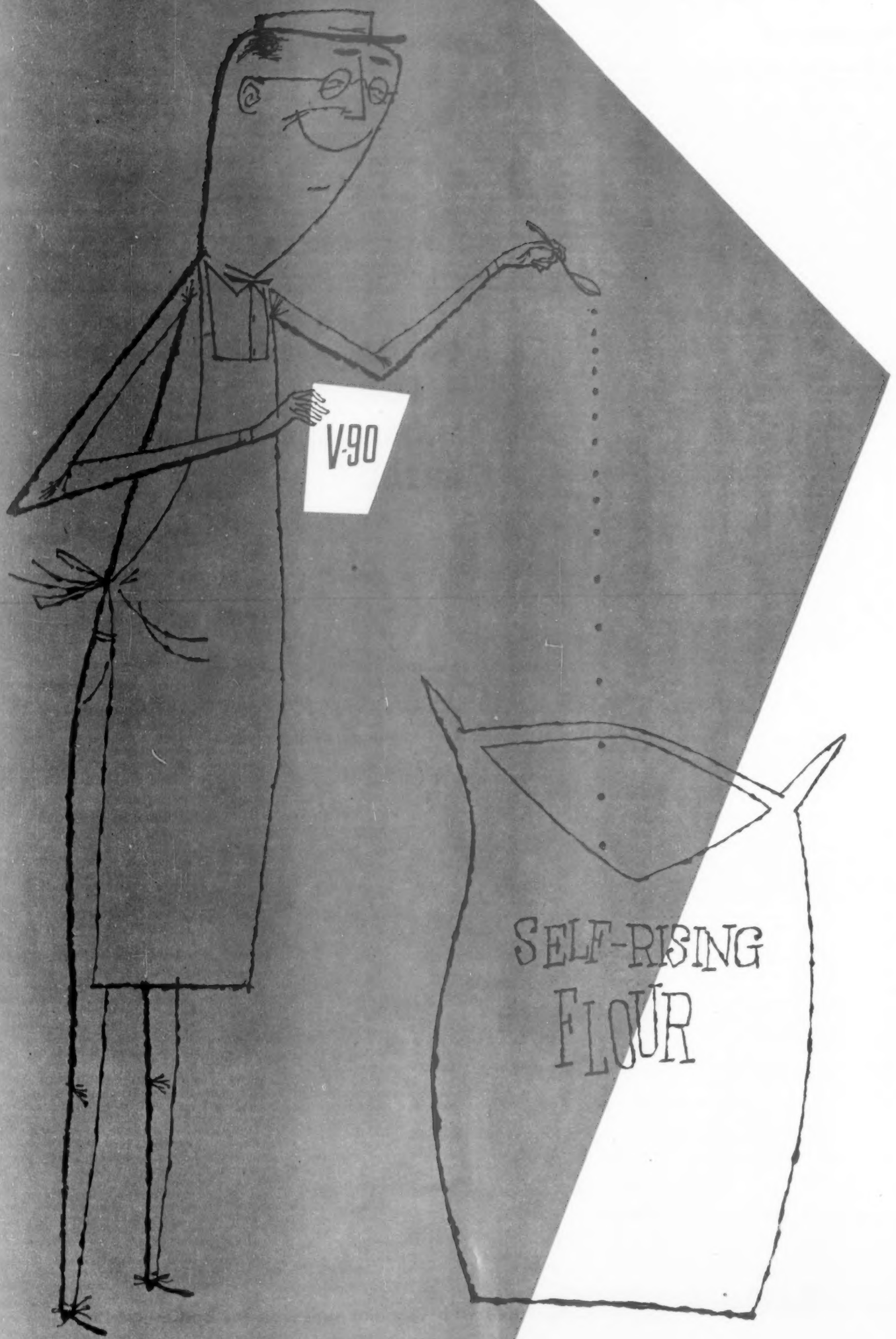
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TABLE I

| WEIGH. NO. | WEIGHT ERROR IN HOPPER (OUNCES) HEAVY | LIGHT | DEVIATION FROM AVERAGE d (OUNCES) | $d^2$ | SAMPLE NO. | SAMPLE AVERAGE X′ (OUNCES) | SAMPLE RANGE R (OUNCES) |
|---|---|---|---|---|---|---|---|
| 1 | 1/4 | | +0.244 | 0.0595 | | | |
| 2 | | 1 1/4 | −1.256 | 1.5775 | 1 | −1.063 | 2.750 |
| 3 | | 2 1/2 | −2.506 | 6.2800 | | | |
| 4 | | 3/4 | −0.756 | 0.5715 | | | |
| 5 | | 1/8 | −0.131 | 0.0172 | | | |
| 6 | 0 | 0 | −0.006 | 0.0000 | 2 | −0.125 | 3.625 |
| 7 | 1 5/8 | | +1.619 | 2.6212 | | | |
| 8 | | 2 | −2.006 | 4.0240 | | | |
| 9 | 2 1/4 | | +2.244 | 5.0355 | | | |
| 10 | 3/8 | | +0.369 | 0.1362 | 3 | +0.094 | 4.000 |
| 11 | | 1 3/4 | −1.756 | 3.0835 | | | |
| 12 | | 1/2 | −0.506 | 0.2560 | | | |
| 13 | 1 1/4 | | +1.244 | 2.7915 | | | |
| 14 | | 1/4 | −0.256 | 0.0655 | 4 | +0.125 | 1.750 |
| 15 | | 1/2 | −0.506 | 0.2560 | | | |
| 16 | 0 | 0 | −0.006 | 0.0000 | | | |
| 17 | | 1/2 | −0.506 | 0.2560 | | | |
| 18 | | 3/4 | −0.756 | 0.5715 | 5 | −0.313 | 1.500 |
| 19 | | 3/4 | −0.756 | 0.5715 | | | |
| 20 | 3/4 | | +0.744 | 0.5536 | | | |
| 21 | 2 1/4 | | +2.244 | 5.0355 | | | |
| 22 | 3 | | +2.994 | 8.9640 | 6 | +1.406 | 3.000 |
| 23 | 0 | 0 | −0.006 | 0.0000 | | | |
| 24 | 3/8 | | −0.369 | 0.1362 | | | |
| 25 | | 1 1/2 | −1.506 | 2.2680 | | | |
| 26 | 1/2 | | +0.494 | 0.2440 | 7 | +0.063 | 3.750 |
| 27 | | 1 | −1.006 | 1.0120 | | | |
| 28 | 2 1/4 | | +2.244 | 5.0355 | | | |
| 29 | | 1/2 | −0.506 | 0.2560 | | | |
| 30 | | 1/2 | −0.506 | 0.2560 | 8 | −0.250 | 3.500 |
| 31 | 1 3/4 | | +1.744 | 3.0415 | | | |
| 32 | | 1 3/4 | −1.756 | 3.0835 | | | |
| 33 | 0 | 0 | −0.006 | 0.0000 | | | |
| 34 | 3 1/2 | | +3.494 | 12.2080 | 9 | +0.313 | 5.250 |
| 35 | | 1/2 | −0.506 | 0.2560 | | | |
| 36 | | 1 3/4 | −1.756 | 3.0835 | | | |
| 37 | 2 1/2 | | +2.494 | 6.2200 | | | |
| 38 | | 2 | −2.006 | 4.0240 | 10 | −0.188 | 4.500 |
| 39 | | 1/4 | −0.256 | 0.0655 | | | |
| 40 | | 1 | −1.006 | 1.0120 | | | |
| SUM | 22 5/8 | 22 3/8 | | 84.9289 | | +0.062 | 33.625 |

AVG. WT. ERROR; $X'' = +\frac{0.25}{40} = +0.006$ oz. $\sigma = \sqrt{\frac{84.9289}{40}}$ $\sigma = \pm 1.457$ oz. $\sigma' = \pm 1.476$ oz. $X'' = 0.006$ oz. $R' = 3.363$ oz.

TABLE II

| WEIGH. NO. | WEIGHT ERROR IN HOPPER (OUNCES) HEAVY | LIGHT | SAMPLE NO. | SAMPLE AVERAGE x (OUNCES) | SAMPLE RANGE R (OUNCES) |
|---|---|---|---|---|---|
| 1 | | 2 | | | |
| 2 | 1 1/4 | | 1 | −0.063 | 3.250 |
| 3 | | 1/2 | | | |
| 4 | 1 | | | | |
| 5 | | 2 | | | |
| 6 | 3/4 | | 2 | +0.188 | 4.500 |
| 7 | 2 1/2 | | | | |
| 8 | | 1/2 | | | |
| 9 | | 1 1/2 | | | |
| 10 | | 1/2 | 3 | −0.875 | 4.500 |
| 11 | | 3 | | | |
| 12 | 1 1/2 | | | | |
| 13 | | 1/8 | | | |
| 14 | 1 5/8 | | 4 | +0.563 | 1.875 |
| 15 | | 1/4 | | | |
| 16 | 1 | | | | |
| 17 | | 2 3/4 | | | |
| 18 | 1/2 | | 5 | −0.500 | 3.500 |
| 19 | 3/4 | | | | |
| 20 | | 1/2 | | | |
| 21 | 0 | 0 | | | |
| 22 | 3 1/2 | | 6 | +0.781 | 4.000 |
| 23 | 1/8 | | | | |
| 24 | | 1/2 | | | |
| 25 | | 1/8 | | | |
| 26 | 1 1/2 | | 7 | −0.094 | 2.875 |
| 27 | | 1 3/8 | | | |
| 28 | | 3/8 | | | |
| 29 | 1/4 | | | | |
| 30 | | 5/8 | 8 | −0.781 | 4.750 |
| 31 | 1 | | | | |
| 32 | | 3 3/4 | | | |
| 33 | | 1/2 | | | |
| 34 | 1/8 | | | | |
| 35 | 1/4 | | | | |
| 36 | 1/8 | | | | |
| 37 | | 2 | | | |
| 38 | 1/8 | | | | |
| 39 | 1/8 | | | | |
| 40 | | 1 1/2 | | | |
| 41 | 1/8 | | | | |
| 42 | 1 | | | | |
| 43 | | 5/8 | | | |
| 44 | | 2 | | | |
| 45 | 1 1/2 | | | | |
| 46 | | 1/8 | | | |
| 47 | | 1 1/2 | | | |
| 48 | | 5/8 | | | |
| 49 | | 7/8 | | | |
| 50 | 2 5/8 | | | | |
| 51 | | 1 3/4 | | | |
| 52 | | 1 | | | |
| 53 | 1 3/4 | | | | |
| 54 | 2 | | | | |
| 55 | 1/2 | | | | |
| 56 | 0 | 0 | | | |
| 57 | 1/8 | | | | |
| 58 | 1/4 | | | | |
| 59 | 1 5/8 | | | | |
| 60 | 3/4 | | | | |

| SAMPLE NO. | SAMPLE AVERAGE x (OUNCES) | SAMPLE RANGE R (OUNCES) |
|---|---|---|
| 9 | 0.000 | 0.750 |
| 10 | −0.781 | 2.175 |
| 11 | −0.375 | 3.000 |
| 12 | −0.188 | 3.000 |
| 13 | −0.250 | 4.375 |
| 14 | +1.063 | 2.000 |
| 15 | +0.688 | 1.625 |

DATA TAKEN 1 MONTH AFTER TABLE I

# CONTROL CHARTS

(Continued from page 1a)

average obtained in the experiment was 5.03. Naturally, the larger the number of tosses, the more nearly the average will approach 5.00 until, with an infinite number of tosses, the average would be 5.00.

Probability theory can also tell us how many times we could theoretically expect to get any number of heads in our coin tossing experiment, and this theoretical number is plotted as the dotted curve in Fig. 1. This theoretical curve is called a "probability curve" or "normal distribution." It is important because it permits us to predict mathematically how often a given event may be expected to occur due to chance alone.

**Determine How Often**

In analyzing data from a test we can determine how often a given reading would occur by chance. If its actual frequency of occurrence is vastly different from the theoretical occurrence, we can safely conclude the reading could not have occurred merely by chance and must have had findable cause for its occurrence.

**3. What standard deviation means.**

An arithmetic average tells us much but does not show how readings vary among themselves. A measure of dispersion, or variation, is therefore of considerable aid because it does just this.

The measure of dispersion that has been most widely used in statistical analysis is the "standard deviation," designated by the Greek letter sigma, $\sigma$. The standard deviation of a set of N number of readings is defined mathematically as the square root of the sum of the squares of individual deviations divided by the number of readings, or symbolically:

$$\sigma = \sqrt{\frac{\Sigma (d^2)}{N}}$$

Standard deviation is a most useful tool. It can be shown that, when the variation of readings is due to chance, 68% of the readings will lie between plus and minus $\sigma$ from the average. Ninety-five per cent of the readings will lie between plus and minus $2\sigma$ from the average and 99.7% of the readings will lie between plus and minus $3\sigma$. This fact is illustrated in Fig. 1.

With this information, we can predict whether a given process will meet specified tolerance limits. It can also give us warning before the limits are actually exceeded in a running process. It works this way: A study is made of the process and about 25 or more successive readings taken. We then calculate the average reading and the standard deviation. We know that there are only three chances in a thousand that any reading will fall outside the limits of plus or minus $3\sigma$ from the average due to chance.

If these readings are within the tolerances permitted for the process, we can say that the process is capable of meeting the desired limits. If, now, we take a small group of sample readings of the process from time to time and find that each reading is within our previously-calculated $3\sigma$ values, we can say that the process is still operating satisfactorily.

If any readings fall outside our

TABLE III

COMP. WEIGHT SET IMPROPERLY

| WEIGH. NO. | WEIGHT ERROR IN HOPPER (OUNCES) HEAVY | LIGHT | SAMPLE NO. | SAMPLE AVERAGE x′ (OUNCES) | SAMPLE RANGE R (OUNCES) |
|---|---|---|---|---|---|
| 1 | | 1 1/4 | | | |
| 2 | 1/4 | | 1 | −0.500 | 3.000 |
| 3 | 1 | | | | |
| 4 | | 2 | | | |
| 5 | | 2 | | | |
| 6 | 1 1/2 | | 2 | −0.813 | 4.000 |
| 7 | | 2 1/2 | | | |
| 8 | | 1/4 | | | |
| 9 | | 3 1/4 | | | |
| 10 | | 1/4 | 3 | −2.125 | 3.000 |
| 11 | | 2 1/2 | | | |
| 12 | | 2 1/2 | | | |
| 13 | | 1 5/8 | | | |
| 14 | | 3 1/2 | 4 | −2.406 | 2.000 |
| 15 | | 1 1/2 | | | |
| 16 | | 3 | | | |
| 17 | | 3 | | | |
| 18 | | 2 1/4 | 5 | −2.188 | 4.500 |
| 19 | | 4 | | | |
| 20 | 1/2 | | | | |
| 21 | | 2 3/4 | | | |
| 22 | | 2 3/4 | 6 | −2.500 | 0.750 |
| 23 | | 2 1/2 | | | |
| 24 | | 2 | | | |
| 25 | | 2 1/2 | | | |
| 26 | | 2 1/4 | 7 | −2.000 | 1.750 |
| 27 | | 3/4 | | | |
| 28 | | 2 1/2 | | | |
| 29 | | 4 | | | |
| 30 | 1/4 | | 8 | −2.281 | 4.250 |
| 31 | | 1 5/8 | | | |
| 32 | | 3 3/4 | | | |
| 33 | | 3/8 | | | |
| 34 | | 2 | 9 | −1.813 | 2.375 |
| 35 | | 2 1/8 | | | |
| 36 | | 2 3/4 | | | |
| 37 | | 1 3/4 | | | |
| 38 | | 4 | 10 | −1.625 | 4.500 |
| 39 | | 1 1/4 | | | |
| 40 | 1/2 | | | | |

TABLE IV

AGITATOR STOPPED

| WEIGH. NO. | WEIGHT ERROR IN HOPPER (OUNCES) HEAVY | LIGHT | SAMPLE NO. | SAMPLE AVERAGE x′ (OUNCES) | SAMPLE RANGE R (OUNCES) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | | | |
| 2 | 1/2 | | 1 | −0.188 | 1.750 |
| 3 | 0 | 0 | | | |
| 4 | | 1 1/4 | | | |
| 5 | | 2 | | | |
| 6 | | 3 | 2 | −1.219 | 4.125 |
| 7 | | 1 | | | |
| 8 | 1 1/8 | | | | |
| 9 | 4 | | | | |
| 10 | | 1/4 | 3 | +0.719 | 6.750 |
| 11 | | 2 3/4 | | | |
| 12 | 1 7/8 | | | | |
| 13 | | 3 1/8 | | | |
| 14 | 1 | | 4 | +0.469 | 5.250 |
| 15 | 2 1/8 | | | | |
| 16 | 1 7/8 | | | | |
| 17 | 5 1/2 | | | | |
| 18 | | 3 1/4 | 5 | +1.531 | 8.750 |
| 15 | 1 5/8 | | | | |
| 20 | 2 1/4 | | | | |
| 21 | 3 1/2 | | | | |
| 22 | | 4 1/4 | 6 | +0.281 | 7.750 |
| 23 | 1 1/8 | | | | |
| 24 | 3/4 | | | | |

3 σ limits we know either that the new variations are caused by something other than chance, or that the process average has shifted. We may then take steps to find the cause. If the permissible tolerances for the process are broader than the 3 σ limits, we are in a position to make corrective adjustments well before the process has actually produced unacceptable results.

### Three Steps in Making-Up a Control Chart

Any process or operation is subject to the laws of probability, and this is just as true of weighing as it is of tossing a coin. We know that, if we have an automatic scale properly adjusted, we will not always weigh-out the exact-same amount of material on successive weighings. Some weighings are slightly heavy and others light. As long as the scale is operating correctly, these variations may be considered due to chance. A record of a large number of them would produce a curve similar to Fig. 1.

Let's consider an actual case of an automatic bagging scale making 100 lb. weighings of poultry mash at high speed. Forty test weighings were taken and each measured to the nearest eighth of an ounce with results as shown in Table I. The average weighing was 0.006 oz. heavy, but individual weighings differed from the average as much as 3½ oz. Our problem is to determine the accuracy of this scale and make up a control chart. With the chart we may then detect whether this accuracy is maintained continually.

**1. Determining standard deviation of individual weighings.**

In Table I are listed the deviations from the average and the squares of the deviations. From this, σ is determined by Equation (1) for the 40 test weighings observed.

To make this a little more general, we use the relationship

$$\sigma' = \sigma \sqrt{\frac{N}{N-1}}$$

in which σ is the standard deviation of the sample of N number of readings and σ′ is the expected or theoretical standard deviation which would result in taking an infinitely large sample from the same "population."

σ′ turned out to be 1.48 oz. Therefore, by chance alone, any individual weighing will not differ from the average by more than thrice this, or 4.44 oz., more often than three times in a thousand weighings.

The 40 individual weighings observed in our tests have been plotted on the left in Fig. 2 and the limit lines at plus and minus 3 σ′ (4.44 oz.) drawn in.

If we extend these limit lines and plot additional weighings, values should fall within the limit lines as long as the process remains in control. When points appear beyond these limits, the scale needs adjustment. Either the weighings are erratic or they are no longer averaging about the correct weight.

We tested the same scale a month after the initial study. Table II was made. These points were plotted in Fig. 2, and the limit lines, established from the first test, extended. Note that all 60 weighings fall well within the limits of ±3 σ′ and seem to oscillate uniformly about the desired 100 lb. value. This shows that the scale is still operating in a state of good control.

To illustrate the sensitivity of statistical control charts in detecting abnormal conditions, the data of Tables III and IV were taken. In Table III the compensation weight (governing the allowance made for the weight of the falling column of material at the instant the scale beam reaches balance) was intentionally fixed to produce light weighings. The weighings are plotted in Fig. 2. No points fall outside the limit lines, but there is a visible shift in the average level of points.

In Table IV the compensation weight was reset. But the agitator providing a uniform stream of material to the weigh hopper was purposely stopped. These readings are also plotted in Fig. 2. The weighings are erratic. One point falls outside the upper control limit. However, note that the average weighing is approximately correct.

**2. Determining "average" and "range" control limits.**

The chart for individual weighings (Fig. 2) is the simplest form of control chart. It serves to warn, but it does not necessarily tell you "findable causes" for altering the process. For this reason, the more sensitive charts for average (X′) and ranges (R) are often used. (Fig. 3.)

In constructing X′ and R charts, a number of small sample weighings, called sub-groups, were taken. The average value and range of values of each sub-group were determined. The usual sub-group size is four weighings. After finding the average and

(Continued on page 16a)


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## No. 5030—Feeder

A new feeder especially designed to control the flow of dry milling powders with precision has been introduced by Sterwin Chemicals Inc. It handles dry powders of variable densities and flow characteristics. It will feed continuously, and in controlled amounts, such dry materials as vitamin enrichment concentrates, micronutrients, leavening agents, powder bleaches, bromate mixtures and mineral mixes. The feed rate is obtained by turning a single, micrometer adjustment knob. This adjustment of the feeding gate, which is made at the start of operations by setting a calibration and the gear ratio, provides a constant rate of flow. The feeder is 27 in. high and requires 22 in. by 27 in. of floor space. A hopper is equipped with an agitator and a transparent plastic cover. The flow can be observed through a plastic window in front of the feeder. Also available from Sterwin is equipment for overhead suction pipe from the feeder to the flow agitator. To secure more complete details check No. 5030 on the coupon and mail it.

## No. 5029—Bin Indicator

A new model bin level indicator incorporating a built-in bull's-eye signal light for use in installations requiring a signal which can be readily seen by an operator, is announced by the Bin-Dicator Co. Called the model "AL" Special Bin-Dicator, it is said to be a complete, visual signal system in one package. It comes assembled and ready for connection to the user's power source. A toggle switch is provided so that the signal light may be shut off if desired. It is claimed to be particularly suitable for use on packaging hoppers, scale hoppers and small bins handling practically any bulk material. To secure more complete details check No. 5029 on the coupon and drop it in the mail.

## No. 5011—Tag Coder

A device for applying a code to the tag has been developed by Mill Engineering Co. for use in connection with its Automatic Bag-Tagger. The coder works on the principle of perforations that are spaced at different intervals and the standard unit is offered in 400 combinations. A coder is also available in 8,000 combinations and by the use of different shaped perforations additional combinations can be secured. The coder is operated by the same air supply that operates the automatic feature of the Bag-Tagger. Inquiries must be accompanied by samples of tags and the sewing machine model and type must be specified. To secure additional information about the coder, check No. 5011 on the coupon. clip and mail it, together with samples of tags and the sewing machine model and type.

## No. 3628—Flour Bin Control

The Fielden Instrument Division, Robertshaw-Fulton Controls Co., an-

nounces the production of a new electronic instrument to control the level of flour in a large holding bin. The instrument is actuated electronically, using a plastic covered or metal sensing probe extending into the tank. The unit is called a Tektor and it contains no moving parts. The instrument is supplied in a variety of weather-resistant, dust-tight and explosion-proof cases, according to the manufacturer. For more complete details check No. 3628 on the coupon and drop it in the mail.

## No. 5044—Batching System

A new electronic batching system is now available for the continuous process industries, according to a recent announcement by the scale division of the Thurman Machine Co. The system, called the Thurma-tronic electronic batching system, is adaptable to either accumulative or consecutive weighing. Controls may be set to weigh one batch or for completely automatic continuous batching. In addition, controls may also be set to weigh any specific number of batches. Thus, all materials in any

formula can be automatically weighed and transferred from storage bins to mixers and processing machinery without delays, the company claims. All new or existing plants can be equipped with this batching system, it is stated. The system permits a batching cycle to be completed in a matter of seconds, it is claimed by company officials. Full details on this batching system and any special accessories, such as strip-chart recorders, one turn dials, etc., may be obtained by checking No. 5044 on the coupon and dropping it in the mail.

## No. 3622—Aptitude Test

Monitored Personnel Measurement is offering business firms a simplified accurate personnel selection method for day-to-day use. The service kit, which is now available from the company can be applied to most clerical and blue collar jobs in business and industry. To secure more complete information check No. 3622 on the coupon and mail it.

## No. 3633—Controls Catalog

A new 12-page general catalog with illustrations, descriptions and basic specifications of Fisher & Porter Company's line of process instrumentation is now available. Instrumentation for measuring and controlling process variables includes: Variable-area and variable-head flow meters; pressure instruments; temperature instruments; liquid level instruments; density and specific gravity measuring instruments; viscosity and consistency instruments; electric,

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## No. 6152—Lift Truck

The Colson Handler, a gasoline powered, rider-type lift truck with hydraulic drive and hydraulic control, is being introduced by the Colson Corp. Main feature of this 4,000 lb. capacity truck is a single control lever for throttle, power lift and direction. When lever is moved forward — or backwards for reverse — a hy-

draulic pump, operating off engine, delivers oil from an oil reservoir to a fluid motor which is linked to the drive wheel by a gear reduction unit. When the lever is lifted, oil is pumped to the platform's load lifting cylinder. The unit automatically shifts from low to high and from high to low either forward or reverse. Cushioned brakes are automatically applied when lever is released. Weighing approximately 1,075 lb., the truck is powered by a 6 h.p., single cylinder, four cycle engine. Maximum speed is four miles per hour. The power unit is 29 in. wide and 30 in. long. The platform is 24 in. wide and is available in seven standard lengths ranging from 30 to 72 in. Lift height is 3 in. To obtain more complete details check No. 6152 on the coupon and drop it in the mail.

## No. 3621—Cargo Heater

Production of a low cost, permanently mounted cargo space heater for full time cargo protection in truck and semi-trailer vans has been an-

nounced by the Rue R. Elston Co., Inc. Termed the "Elston X-1000 Series," the L.P. gas-fired heater has a 16,000 BTU capacity and can be controlled either manually or thermostatically (optional). A 20 lb. propane bottle will last 31 hours at continual operation — with thermostatic controls, the unit will burn up to 58 hours on a single tank. The heater consists of two basic units—heater assembly and bottle carrier—and, according to the manufacturer, the cargo heater can be permanently mounted in a truck or trailer van with very little effort. To secure more complete information check No. 3621 on the coupon and mail it.

## No. 5045—Packaging Bulletin

The Triangle Package Machinery Co. announces the availability of a six page bulletin, "Profitable Solution to Your Package Filling Problems." The bulletin describes the firm's line of Elec-Tri-Pak net weighing and filling machines and lists the advantages of using a unit to do many of the packaging jobs now done by hand. Six models, from the automatic, one-scale model A1C to the three-scale model A3C are described in the bulletin. The bulletin also points out that there is a semi-automatic or an automatic machine for packaging nearly any type of dry product into most any style container. Copies of the bulletin may be obtained by checking No. 5045 on the coupon and mailing it to this publication.

## Accident Rates

CHICAGO — The National Safety Council has published a booklet on accident rates in 1953 in the food and other industries. Included in the publication is information on injury rates in the grain milling field.

The booklet contains the 1953 accident experience of companies which report to the National Safety Council.

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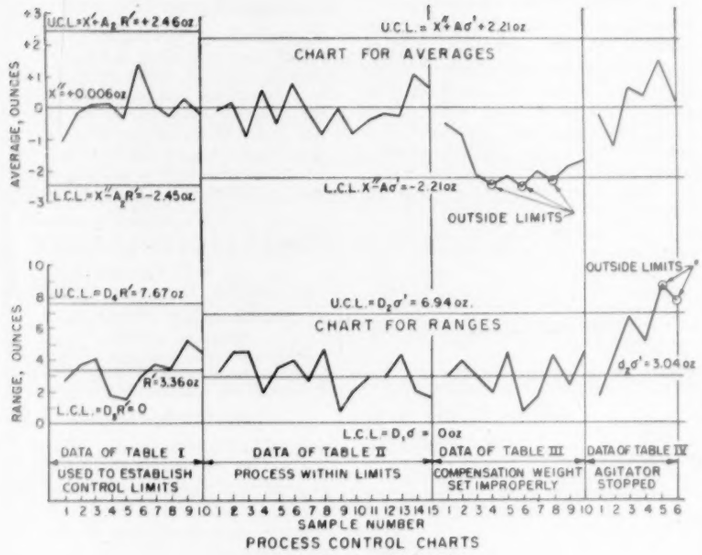


PROCESS CONTROL CHARTS
100 LB. DRAFTS — HIGH SPEED
POULTRY MASH
FIGURE 3

TABLE V
SHEWHART CHARTS FOR AVERAGES

| NUMBER OF OBSERVATIONS IN SAMPLE n | CONSTANTS FOR COMPUTING CONTROL LIMIT FOR AVERAGE AND RANGE TO SEE IF AN UNKNOWN PROCESS IS IN CONTROL: FACTOR FOR X′ CHART $A_2$ | FACTORS FOR R CHART: LOWER CONTROL LIMIT $D_3$ | FACTORS FOR R CHART: UPPER CONTROL LIMIT $D_4$ | CONSTANTS FOR COMPUTING LIMIT LINES TO DETERMINE IF A KNOWN PROCESS REMAINS IN CONTROL: CHART FOR AVERAGES: CONSTANT FOR CONTROL LIMITS $A(=3/\sqrt{n})$ | CHART FOR RANGES: CONSTANT FOR CENTRAL LINE $d_2$ | CHART FOR RANGES: CONSTANTS FOR CONTROL LIMITS $D_1$ | CHART FOR RANGES: CONSTANTS FOR CONTROL LIMITS $D_2$ |
|---|---|---|---|---|---|---|---|
| 2 | 1.88 | 0 | 3.27 | 2.12 | 1.13 | 0 | 3.69 |
| 3 | 1.02 | 0 | 2.57 | 1.73 | 1.69 | 0 | 4.36 |
| 4 | 0.73 | 0 | 2.28 | 1.50 | 2.06 | 0 | 4.70 |
| 5 | 0.58 | 0 | 2.11 | 1.34 | 2.33 | 0 | 4.92 |
| 6 | 0.48 | 0 | 2.00 | 1.22 | 2.53 | 0 | 5.08 |
| 7 | 0.42 | 0.08 | 1.92 | 1.13 | 2.70 | 0.20 | 5.20 |
| 8 | 0.37 | 0.14 | 1.86 | 1.06 | 2.85 | 0.39 | 5.31 |
| 9 | 0.34 | 0.18 | 1.82 | 1.00 | 2.97 | 0.55 | 5.39 |
| 10 | 0.31 | 0.22 | 1.78 | 0.95 | 3.08 | 0.69 | 5.47 |
| 11 | 0.29 | 0.26 | 1.74 | 0.90 | 3.17 | 0.81 | 5.53 |
| 12 | 0.27 | 0.28 | 1.72 | 0.87 | 3.26 | 0.92 | 5.59 |
| 13 | 0.25 | 0.31 | 1.69 | 0.83 | 3.34 | 1.03 | 5.65 |
| 14 | 0.24 | 0.33 | 1.69 | 0.80 | 3.41 | 1.12 | 5.69 |
| 15 | 0.22 | 0.35 | 1.65 | 0.77 | 3.47 | 1.21 | 5.74 |
| 16 | 0.21 | 0.36 | 1.64 | 0.75 | 3.53 | 1.28 | 5.78 |
| 17 | 0.20 | 0.38 | 1.62 | 0.73 | 3.59 | 1.36 | 5.82 |
| 18 | 0.19 | 0.39 | 1.61 | 0.71 | 3.64 | 1.43 | 5.85 |
| 19 | 0.19 | 0.40 | 1.60 | 0.69 | 3.69 | 1.49 | 5.89 |
| 20 | 0.18 | 0.41 | 1.59 | 0.67 | 3.74 | 1.54 | 5.92 |
| | CHART FOR AVERAGES: CENTRAL LINE IS AT $X''$; UCL = $X''+A_2R'$; LCL = $X''-A_2R'$ CHART FOR RANGES: CENTRAL LINE IS AT $R'$; UCL = $D_4R'$; LCL = $D_3R'$. | | | CHART FOR AVERAGES: CENTRAL LINE IS AT $X''$; UCL = $X''+A\sigma'$; LCL = $X''-A\sigma'$ CHART FOR RANGES: CENTRAL LINE = $d_2\sigma'$; UCL = $D_2\sigma'$; LCL = $D_1\sigma'$. ($\sigma'$ = EXPECTED VALUE OF $\sigma$) | | | |

## CONTROL CHARTS

(Continued from page 13a)

range for each of the ten sub-groups shown in Table I, the grand average X″ and the average range, R′, were also computed.

We then set up trial control limits for the average X′ and R instead of the individual weighing. This is simply a matter of arithmetic. Statistically, the upper and lower limits for averages are given by $X'' \pm A_2 R'$, respectively, and the upper and lower limits for ranges are given by $D_4R'$ and $D_3R'$, respectively.

The quantities $A_2$, $D_3$ and $D_4$ are derived from $\sigma$ and depend on the sub-group size. They are standard statistical symbols and are listed in Table V. The left side of Fig. 3 shows the charts made as a result of our initial test of Table I, and the appropriate limit lines have been drawn in. Note that it is customary to place the X′ chart directly over the R chart for ready comparison.

None of the points taken from Table I lies outside the limit lines on either the X′ or R chart, indicating that the process is in control. Whether the limits of this state of control are satisfactory depends on the requirements of the process. In the tests reported, the individual weighings fell within a 3 $\sigma$ limit of approximately ¼%. This is usually considered very satisfactory.

Should a point fall outside the limit lines of the X′ chart, it means a change tending to affect all weighings because it has been of a nature to alter the sub-group average. On the other hand, a point outside limits on the R chart denotes a change in the uniformity of the process.

**3. Setting up limits.**

Once the initial data have been collected, the charts made, the process found to be in control and within specification tolerances, we are ready to prescribe the limits for future use. Since we do not know what the sub-group average range will be for the future weighings, the limit lines for the X′ and R charts must be based on $\sigma'$, the expected standard


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deviation of the process, and the grand average of the initial study. The limits for averages will be $\bar{X}'' \pm A\,\sigma'$. The central line on the chart for ranges will be $d_2\,\sigma'$, the lower control limit $D_1\,\sigma'$ and the upper control limit $D_2\,\sigma'$. The appropriate values of A, $d_2$, $D_1$ and $D_2$ are given in Table V.

**How to Use Your Charts**

To find out if a process is remaining in control, subgroup weighings are taken at suitable intervals, such as each hour. Each subgroup must, of course, contain the same number of consecutive weighings as was used in each subgroup in setting up the control limits in the first place.

Data from Table II, taken a month after the initial study, fall within the limit lines in Fig. 3 and show that a good state of control is still being maintained. The limit lines used for these $\bar{X}'$ and R charts (Fig. 3, are based on data from Table I and the weighings shown to be in a satisfactory state of control.

Data from Table III (light weights) was then plotted. Three points were found to be outside limits on the chart for averages. The general shift in average is apparent.

The graph for ranges, however, is still in good control. This indicates that the variation within the process is still acceptable but a shift has occurred in the whole level of the process.

Data from Table IV (resulting from purposely stopping the agitator in the feed stream) show averages in control, but ranges out of control. One point is almost on, and two points outside, the limit lines. In this case the process level is satisfactory, but the variation within the process unsatisfactory.

This is also proved by further analysis of the data in Table IV. One finds that the grand average, $\bar{X}''$ for the 24 weighings is a quarter ounce heavy, but the standard deviation, $\sigma'$, is now 2.43 oz. or almost twice the value of $\sigma'$ when the process was in a state of control.

## FUTURE MILL

(Continued from page 9a)

where, say, a 50-sack plant is now installed, it should be possible to accommodiate a plant of more than double that size and so to produce in, say, 8 hours what it now takes 24 hours to produce.

With the advent of the pneumatic equipped, electrically driven and operated mill, the question of continuous running of the plant is not now one of paramount importance. I see no reason why a mill should work more than, say, eight hours per day and in this time produce the same amount of flour that it now does in 24 hours. Night work in mills has never been considered satisfactory and the removal of this nightly vigil would be welcomed as a step in the right direction of putting the industry on a modern basis compatible with that found in many other industries.

**J. H. Scott's "Expositions"**

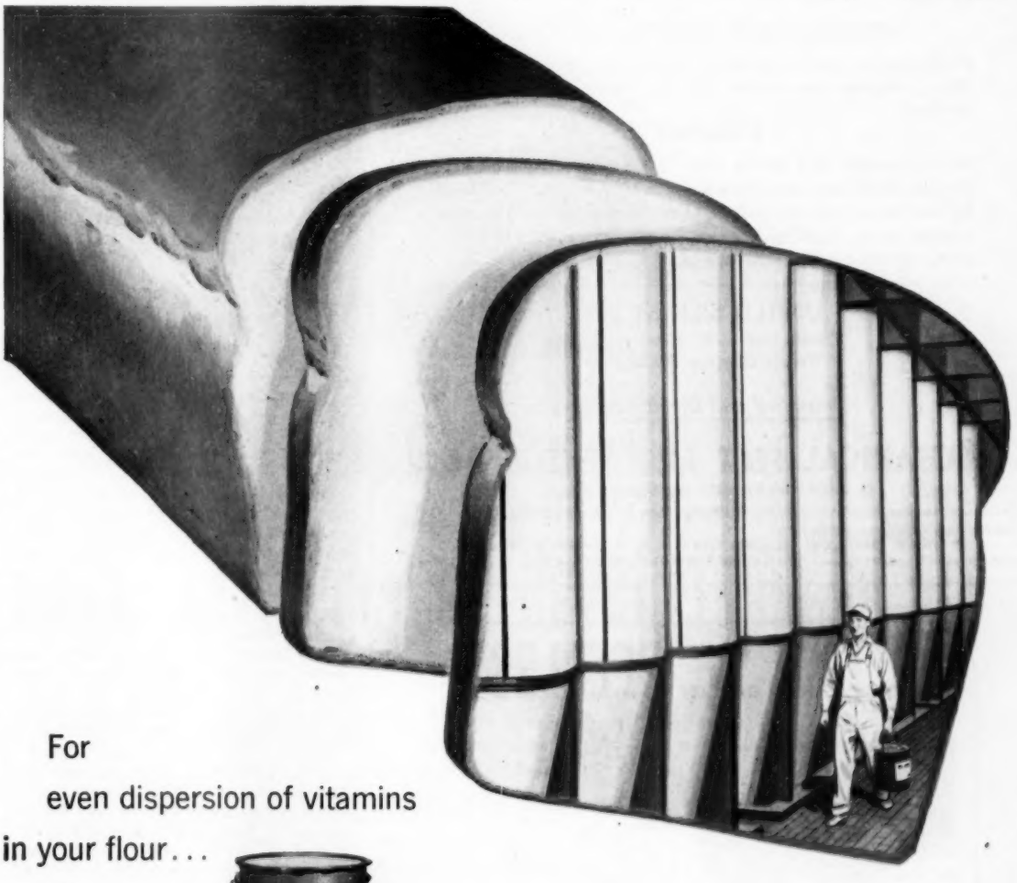
There are many of us who feel that the future development of flour milling will be carried out along these lines. Fortunately, these opinions are shared by others better qualified to speak than myself, one of whom is James Hay Scott, who, in 1936, published a book, "Flour Milling Processes," which, in my opinion, is by far the best exposition of flour milling ever to be written. It is a brilliant effort which for some reason or other has never received the measure of support afforded to other technical publications. Scott's book, however, must not be classed as a text book for budding millers; it is a scientific appraisal of flour milling written by a specialist who thoroughly understands his subject and, as might be expected, such a work has only a limited appeal.

Scott later wrote a series of articles "Flour Mills of the Future," published in Milling during 1949, which shows he is a thinker of the first order who is apparently profoundly dissatisfied with the old order of things and is most anxious for a change. He has given his reasons how the changes can be brought about.

To quote Scott: "The orthodox milling process is unduly long and complicated, the machines themselves over large and elaborate for the work they have to do." Scott's views on the roller mill are very interesting and he goes on to say: "In spite of its increased size and mechanical perfection, it is still handling only a relatively small amount of stock—there is no need for such large rollers and such a powerful and heavy machine." Scott suggests that rollers of only three inches diameter contained in what he calls a multiple roller mill might be satisfactory.

**Purification**

On the subject of purifiers, there are many like myself who have come to regard purification with very mixed feelings, for what I consider are two very good reasons. Firstly, purification cannot be claimed to be an absolutely essential service like grinding or dressing; this is borne out by the fact that for many years a firm of millers in the U.K. controlling

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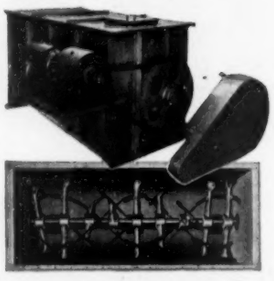

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several large mills were distinctly opposed to purifiers as such and not a single orthodox machine was to be found in any of their mills; yet the firm flourished and successfully competed against the orthodox equipped mill. Secondly, I consider machines employing the principle of moving air currents in order to effect a separation are far from being fully efficient owing to the non-uniformity of air motion.

Scott suggests the possibility of combining purification with sifting or alternatively a method of electrical separation may be developed for this work, which of course, is not a new suggestion, for as far back as 1880 the Americans had invented a purifier employing the principle of removing impurities by frictional electricity. One of these machines was exhibited at the London exhibition of 1881, the inventors claiming that a similar machine had been working in a large mill in the States for over a year; while some 30 years later a German firm put on the market a form of electric purifier called the "Dielektra," which was similar in principle to the American machine, both of which survived for only a short time. As this is the age of electricity, perhaps some wizard will oblige with a modern version.

Summing up, Mr. Scott advocates the use of roller mills containing several stages in one frame, roll speeds much higher than at present, quicker reducing of reduction stocks on special grinders, disintegration of flour flakes on high speed "disrupters," and the development of multiple roller mills with very small diameter rollers.

Mr. Scott ends with these words: "I am well aware that there is a very great difference between putting down fancy and wishful dreams on paper and the translation of these into practical and satisfactory operation. I am sure, however, that many of my colleagues share my belief that changes must come in the future."

Flour milling as a hit-and-miss affair governed by rule-of-thumb methods was bequeathed to us, we had to accept it, but now it appears to be definitely moving into the realm of scientific application of the principles governing the manufacture of flour.

The mill of the future is taking shape. This is not a prophecy, the outline is already there and further gradual development of new and existing ideas will slowly bring about far-reaching changes in our methods of manufacture. The prophecy of the wise old sage of 1898 looks like being realized at long last.

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## Air Pollution Symposium

PALO ALTO, CALIF. — The 3rd National Air Pollution Symposium will be held April 18-19, 1955, at the Huntington-Sheraton Hotel, Pasadena, Cal.

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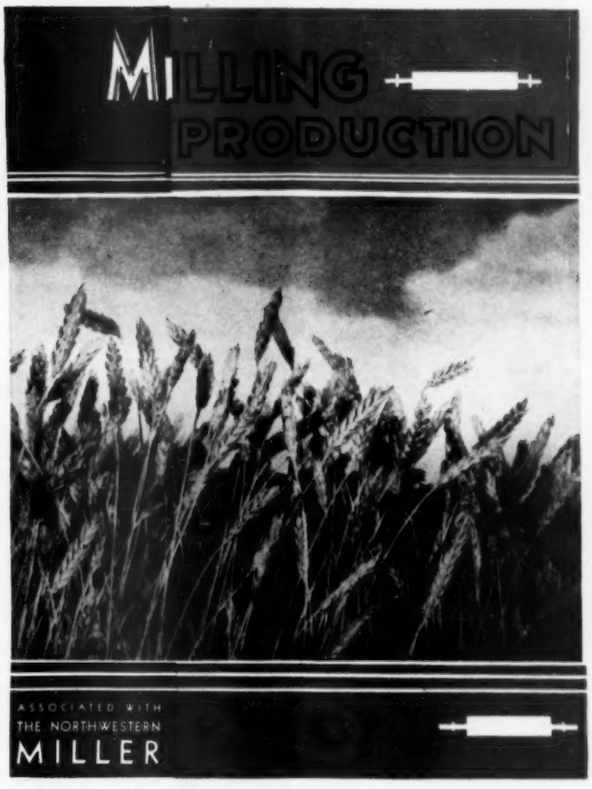


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